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ISBN
9783031273292

Authors
Stroth, Luke
Garvin Suero, Arianna
Liss, Brady
et al.

Publication Date
2023

DOI
10.1007/978-3-031-27330-8_48

Archaeological Evidence of Casual Snacking and Resource Provisioning at Khirbat al-Jariya (ca. Eleventh to Tenth Centuries BCE), an Iron-Age Copper Production Site

Luke Stroth, Arianna Garvin Suero, Brady Liss, Matthew D. Howland, and Jade D'Alpoim Guedes

Abstract In this chapter we present the results of a paleobotanical analysis of Khirbat al-Jariya, an Iron-Age (ca. eleventh to tenth centuries BCE) copper smelting workshop in Faynan, Jordan. The macrobotanical collection was dominated by easily procured fruits and nuts that required little preparation, such as dates (*Phoenix dactylifera*), grapes (*Vitis* sp.) and figs (*Ficus* sp.) which we characterize as likely "snack foods." Evidence for grain processing, in terms of cleaning and removal of chaff, is largely absent, and there is no meaningful spatial patterning to the discard of food debris. This suggests that food consumption was a casual process at Khirbat al-Jariya and that food products requiring preparation were processed elsewhere. Comparing this data to that of contemporary sites indicates that this dominance of snack foods is particular to the Faynan region. It is possible that Khirbat al-Jariya was only seasonally occupied, under which circumstances a practice of casual snacking supplemented by prepared foods from elsewhere was sustainable. This complicates the typical binary of "consumer" and "producer," and we argue that such distinctions may be as much a result of sampling strategies and spatial patterning. We also evaluate how sampling strategies played a role in interpreting the data from Khirbat al-Jariya, which may represent the casual snacking behavior associated with an itinerant industrial community rather than the full spectrum of subsis-

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/978-3-031-27330-8_48.

L. Stroth (✉) · A. Garvin Suero · B. Liss · J. D'Alpoim Guedes
University of California, San Diego, La Jolla, CA, USA
e-mail: lstroth@ucsd.edu; agarvin@ucsd.edu; bliss@ucsd.edu; jguedes@ucsd.edu

M. D. Howland
Laboratory of Archaeology, University of Georgia, Athens, GA, USA
e-mail: mdh5169@gmail.com

E. Ben-Yosef, I. W. N. Jones (eds.), *"And in Length of Days Understanding" (Job 12:12): Essays on Archaeology in the Eastern Mediterranean and Beyond in Honor of Thomas E. Levy*, Interdisciplinary Contributions to Archaeology,
https://doi.org/10.1007/978-3-031-27330-8_48

tence during the Iron Age of the Wadi Faynan. Although all societies are some combination of producer and consumer, we argue that the inhabitants of Khirbat al-Jariya were much closer to the consumer end of the spectrum based on both positive evidence for the dominance of snack foods and the negative evidence for food preparation. Their diet consisted of convenient, although seasonal, snack foods, for which the archaeological signal is high, and prepared foods that have not preserved, for which the archaeological signature for local production is almost negligible.

Keywords Paleobotany · Snacking behavior · Paleobotanical sampling · Wadi Faynan · Iron Age archaeology · Consumer-producer spectrum

1 Introduction

Archaeologists have applied a useful, but necessarily simplified, producer-consumer spectrum to describe the suite of food acquisition practices in use at a particular site (e.g., Clark, 1996; Costin, 2001). Comparative ratios of wild to domestic taxa have been used to determine if the inhabitants of certain sites were primary agricultural producers or received cleaned grain from elsewhere (e.g., Fuller & Stevens, 2009). This does assume that there is a clear archaeological signature of a platonic producer and consumer site which may overlook connections or seasonal movement of people between different sites. Very few analyses, however, have looked at the proportions of foods that are transportable and "snackable" foods, such as dates (*Phoenix dactylifera*) or figs (*Ficus* sp.), to foods that require milling or other preparation, such as wheat (*Triticum* sp.) or barley (*Hordeum* sp.). We explore these issues at Khirbat al-Jariya (KAJ), an Iron-Age (ca. eleventh to tenth centuries) copper smelting site in the Faynan region of southern Jordan and propose that high signal of snacking foods can be added to the archaeological correlates of itinerant metallurgists (Ben-Yosef, 2019:362).

In this chapter, we report on the results of a macrobotanical analysis conducted on samples from the 2014 excavation at the site. These samples were collected from a stone structure (Building 2/Area B; Liss et al., 2020) and an industrial slag mound (Area C; Liss et al., 2020). We ask: how did the Iron-Age metalworkers feed themselves? Did they produce their own food, or did they acquire prepared foods through trade or a local sponsor? To what extent did they incorporate convenient "snackable" foods that required no processing? These questions are particularly significant given the desert environment of Faynan (Palmer et al., 2007). We began our analysis with the expectation that the collection would not show evidence for on-site food production given the desert context of the site. If KAJ residents were dependent on a local supplier for their survival, it may suggest that the occupants of KAJ were attached specialists embedded in the economies of the larger region (Clark, 1996; Costin, 2001). This interpretation is supported by recent data indicating that the origins of KAJ were closely tied to the rapid development of the copper-producing industry in the region (Ben-Yosef et al., 2010; Levy et al., 2016), potentially spurred by contact with or emulation of external imperial influences (Ben-Yosef, 2019:364; Ben-Yosef, 2021:162).

Our analysis revealed an overall dominance of fruit and nut taxa that could be sourced locally from nearby sites such as Khirbat al-Ghuwayba, which saddles a perennial spring that feeds local orchards. Other foods that require preparation, such as wheat and barley grains which must be milled into flour to make bread, appear commonly in archaeobotanical assemblages across the region yet are not well represented at Khirbat al-Jariya (Table 1; Supplemental Table 1). The content of the KAJ paleobotanical collection is compared to other sites in the region, which overall demonstrated greater dependence on prepared cereals and less frequent exploitation of fruits, nuts, and other "snack" foods. Our results are consistent with observations from other metalworking sites, such as Timna Valley Site 30 (David et al., 2022). We consider the role that spatial bias may play in the interpretation of this data and discuss the archaeological correlates to casual snacking behavior. We argue that the workers' diets at this site focused on the transport of foods that were either fully prepared, such as baked bread (which leaves little trace in the archaeobotanical record), or on dried/pickled/preserved fruit and nut-based snack foods. This supports prior interpretations that KAJ was occupied by itinerant-worker communities, perhaps supported by the nearby Khirbat en-Nahas. This paper serves as a contribution to Iron-Age paleobotany, a literature for which the "relative dearth of paleoethnobotanical studies" has been noted (Farahani et al., 2016:28). This is the first report of a paleobotanical sample from a metal-working context recovered through systematic flotation (but see David et al., 2022).

2 Archaeological Background to the Faynan Region

The Faynan region of southern Jordan is a small, arid box-canyon rich in copper ores approximately 30 kilometers south of the Dead Sea. Faynan is located in the Saharo-Arabian desert, characterized by a hot and arid climate. The average annual rainfall in Faynan today is only 50–60 millimeters and is highly variable (Palmer et al., 2007). Despite this desert environment, the archaeological record shows that the abundant copper ores of Faynan were exploited since as early as the ninth millennium BCE and intermittently mined into the Islamic period (Ben-Yosef et al., 2010). In the Iron Age (ca. twelfth–ninth centuries BCE), copper production in Faynan reached its industrial peak when the region was characterized by large smelting centers and mining camps (Fig. 1a; Ben-Yosef et al., 2010; Ben-Yosef et al., 2019; Hauptmann, 2007; Levy et al., 2014). Excavations at copper smelting sites in Faynan offer comprehensive records on the timing, scale, and management of copper production during the Early Iron Age, potentially connected to the Biblical Kingdom of Edom (Ben-Yosef, 2010; Ben-Yosef et al., 2019; Levy et al., 2014).

The archaeological and archaeometallurgical findings at Khirbat en-Nahas, Khirbat al-Jariya, and Khirbat al-Ghuwayba, three Iron-Age smelting sites,

Table 1 Total counts and weights of taxa from KAJ

Taxa	Common name	Organ	Condition[a]	Total (count)	Total (weight)
Grains					
Avena/Secale sp.	Oat/Rye	Seed	W	3	0.0077
Cerealia		Seed	W	12	0.044
cf. Cerealia		Seed	W	21	0.1509
Hordeum vulgare	Barley	Grain	W	18	0.1172
Hordeum vulgare	Barley	Grain	F	14	0.0777
Hordeum vulgare	Barley (two-row)	Rachis	W	3	<0.0001
Hordeum vulgare	Barley (hulled)	Grain	W	10	0.0612
Hordeum vulgare	Barley (hulled)	Grain	F	1	0.007
Panicoideae		Seed	W	1	<0.0001
Triticum sp.	Wheat	Grain	W	9	0.0691
Triticum aestivum	Wheat (rachis)	Rachis	W	1	<0.0001
Triticum/Hordeum sp.	Wheat/Barley (seed)	Grain	W	4	0.1095
Triticum/Hordeum sp.	Wheat/Barley	Rachis	F	20	0.0031
Pulses					
Cicer sp.	Chickpea	Seed	W	1	0.1112
cf. *Cicer* sp.	cf. Chickpea	Seed	W	2	0.0975
Fabaceae		Seed	F	17	0.0261
Lens culinaris	Lentil	Seed	W	133	0.6527
Lens culinaris	Lentil	Seed	F	2	<0.0001
Lens/Pisum sp.	Lentil/Pea	Seed	W	35	0.1139
cf. *Lens* sp., cooked	Lentil	Seed	W	4	0.0045
Pisum sativum	Pea	Seed	W	14	0.2299
Pisum sativum	Pea	Seed	F	7	0.0423
Fabaceae	Unidentified domesticated Fabaceae	Seed	W	2	0.0287
Fabaceae	Unidentified wild Fabaceae	Seed	W	2	<0.0001
cf. *Vicia faba*	Faba bean	Seed	W	2	0.0136
Vicia sp.	Vetch	Seed	W	9	0.0502
Fruits					
cf. *Ficus* sp.	cf. Fig	Seed	W	1080	0.2584
Ficus sp.	Fig	Fruit	F	2	0.0206
Phoenix dactylifera	Date palm	Pit	W	135	12.6425
Phoenix dactylifera	Date palm	Pit	F	380	11.9723
Phoenix dactylifera	Date palm	Fruit	W	1	0.4225
Phoenix dactylifera	Date palm	Fruit and Pit	F	3	0.3653
cf. *Pistacia* sp.	cf. Pistachio	Seed	W	8	0.0151
Punica		Seed	W	1	0.0453

(continued)

Table 1 (continued)

Taxa	Common name	Organ	Condition[a]	Total (count)	Total (weight)
cf. *Rubus* spp.	Rose	Seed	W	1	<0.0001
Vitis sp.	Grapevine	Seed	W	110	1.1797
Vitis sp.	Grapevine	Seed	F	98	0.2379
	Unidentified Fruit	Seed	W	1	0.0035
	Unidentified Fruit	Skin	F	2	0.0113
	Unidentified endocarp	Endocarp	F	3	0.0569
Fiber					
cf. *Linum* sp.	cf. Flax	Seed	F	4	0.0037
Linum usitatissimum	Flax	Seed	F	17	0.025
Weeds/ Wild					
Amaranthaceae	Amaranth	Seed	W	1	<0.0001
Boraginaceae	Borage	Seed	W	8	0.0123
Coix sp.	Job's Tears	Seed	W	1	0.0025
Cyperaceae		Seed	W	7	<0.0001
Chenopodium sp.	Goosefoot	Seed	W	2	<0.0001
Galium sp.	Bedstraw	Seed	W	7	0.0124
cf. *Juniperus* sp.	cf. Juniper	Seed	W	2	0.0203
Poaceae		Seed	W	3	0.0085
Poaceae	Wild Poaceae	Seed	W	20	0.0206
cf. Malvaceae	Mallows	Seed	W	2	0.0004
cf. *Tribulus*/*Juniperus* sp.		Seed	W	1	0.0038
cf. Solanaceae	cf. Nightshades	Seed	W	1	0.0785

[a]*W* whole specimen, *F* fragment

complement each other to provide insight into Iron-Age industry (Ben-Yosef et al., 2010). Khirbat en-Nahas, which translates to "ruins of copper" in Arabic, was occupied from the twelfth- to ninth-century BCE (Levy et al., 2014; Levy et al., 2016). Khirbat en-Nahas has been subject to significant archaeological attention, being both the largest Iron-Age, copper-smelting site and the center of the copper industry in Faynan during this period (Levy et al., 2014), with the most significant production dating to the early tenth- to ninth-century BCE (Ben-Yosef et al., 2010; Levy et al., 2014). The size of the fortress, containing over 100 architectural structures and 50–60,000 tons of slag, attest to the scale of the industry at this site (Hauptmann, 2007; Levy et al., 2014).

Khirbat al-Jariya (Fig. 1b), another Iron-Age, copper-smelting site and the focus of this analysis, is located approximately 2 kilometers north-east from Khirbat en-Nahas (Levy et al., 2018). The site was dated to the eleventh–tenth centuries BCE and includes an estimated 15–20,000 tons of copper slag (Hauptmann, 2007; Liss et al., 2020).

Finally, Khirbat al-Ghuwayba was a smaller-scale, copper-smelting site located about 2.5 kilometers southeast of Khirbat al-Jariya and adjacent to a perennial spring, Ain al-Ghuwayba. This spring provides enough water for modern fruit orchards, and it was likely an important resource in the Iron Age (Ben-Yosef, 2010; Liss et al., 2020). Excavations dated the site to eleventh–tenth centuries BCE based on radiocarbon samples, and this dating is supported by the similarity to archaeometallurgical material at Khirbat al-Jariya (Ben-Yosef, 2010). Based on excavations at these sites (and others in the region), Early Iron-Age settlement in Faynan is represented by an "industrial landscape" in the region focused primarily on mining and smelting copper (Ben-Yosef et al., 2010; Ben-Yosef et al., 2019; Liss et al., 2020). Copper production was centered at Khirbat en-Nahas, and Khirbat al-Jariya likely was occupied as an organized expansion of production during the mid-eleventh century BCE (Liss et al., 2020). Khirbat al-Ghuwayba played a smaller role in copper production but could have controlled the spring as an important water source.

2.1 Khirbat al-Jariya

In 2006, the Edom Lowlands Regional Archaeology Project (ELRAP), directed by Thomas E. Levy and Mohammad Najjar, excavated at Khirbat al-Jariya for the first time under the field supervision of Dr. Erez Ben-Yosef (Ben-Yosef et al., 2010). ELRAP developed the stratigraphy in Area A (A1-A6) based on the excavation of a small structure and a slag mound probe (Ben-Yosef et al., 2010). Radiocarbon dating along with geomagnetic archaeointensity connected the area's stratigraphy to the stratigraphy at Khirbat en-Nahas, establishing the contemporaneity of the two sites during the Iron Age. To expand on the 2006 results and to develop a more profound understanding of how Khirbat al-Jariya was situated in the culture of Iron-Age copper production in the Faynan region, ELRAP returned to the site in 2014 and excavated two contexts, Area B/Building 2 (Fig. 2a) and Area C (Fig. 2b). Area B/Building 2 is the largest extant architectural structure (ca. 7.5 × 7.5 m) at Khirbat al-Jariya and was likely first occupied in the mid-11th BCE (Liss et al., 2020). The building, which includes four to seven rooms, was potentially an elite residence or served administrative purposes with connections to an industrial function (Liss et al., 2020). Area C was a 1 × 1 meter probe into a large slag mound on the south-eastern edge of the site (Liss et al., 2020). The sounding was excavated to bedrock at a depth of about 1.75 meters,

Of the 3292 charcoal fragments recovered from dry screens from excavations in Areas B and C, 90% were identified to 22 taxa by visual identification using stereo and polarizing microscopes (Liss et al., 2020). Sixty-four specimens were analyzed using a scanning electron microscope to identify the presence or absence of fungal hyphae, filamentous structures that grow in deadwood. The most abundant taxa, which appeared in all loci, were tamarisk (*Tamarix* sp.) and white broom (*Retana raetam*). These taxa, along with acacia (*Acacia tortilis*), which appears in at least half of the samples, are local to the region, growing in the wadis and interfluvial zones of the dry Faynan box canyon (Levy et al., 2018).

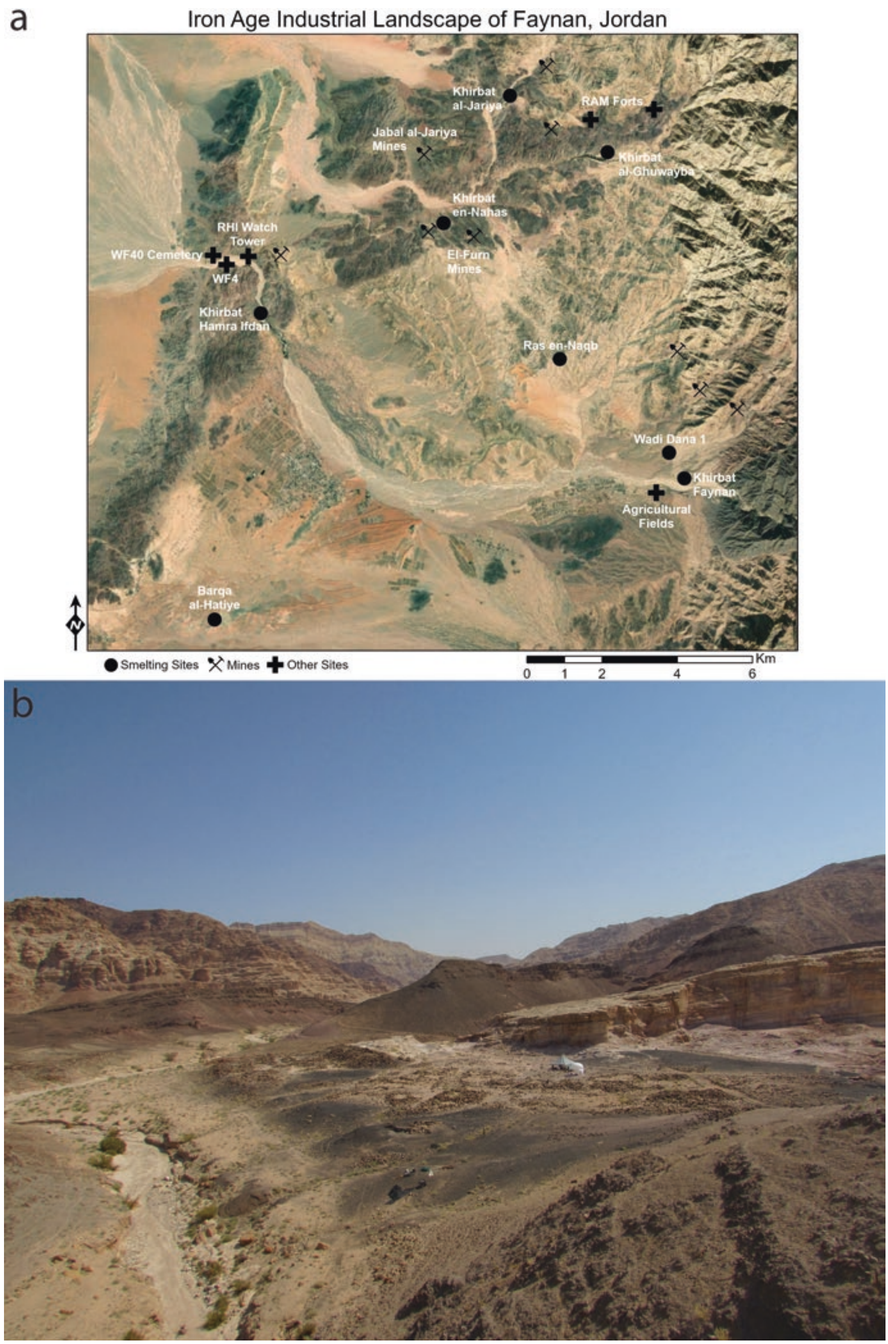


Fig. 1 (**a**) Major Iron Age sites within the Faynan copper ore district; (**b**) Khirbat al-Jariya looking roughly North. Map and photograph by Brady Liss

Fig. 2 (**a**) Aerial image of completed Area B excavation; (**b**) photograph of completed probe in Area C slag mound. Photographs from the UC San Diego Levantine and Cyber-Archaeology Laboratory

Study of fuelwood from Wadi Arabah likewise showed a preference for local taxa (Engel, 1993). Wood from date palm (*Phoenix dactylifera*) and olive trees (*Olea europaea*) appear in at least half of the samples, and wood from fig (*Ficus* sp.), and grape (*Vitis vinifera*) appear in fewer than that. *Phoenix dactylifera* does grow locally, although is limited in distribution to the perennial spring-fed oases (Levy et al., 2018). Grape vines would have had to have been imported from a region with a less arid climate. Ben-Yosef et al. (Ben-Yosef et al., 2017) speculate that they could have been imported from the highlands of Edom. The presence of wood remains from fruit-producing trees suggest that at least one important source of firewood for the inhabitants of KAJ was the cuttings removed during the maintenance of orchards (Liss et al., 2020:8). This material may have been acquired from Khirbat al-Ghuwayba if that site did indeed mediate access to the perennial spring and associated resources, or from the Mediterranean climatic strip around the Edomite Plateau (Ben-Yosef, 2019:369; Ben-Yosef, 2023:247). A similar sustainable model of fuelwood coming from deadwood and coppicing has been described elsewhere (Levy et al., 2018). As an interesting comparison point, study of the fuelwoods from Megiddo showed an overall increase in reliance on fruit woods at the expense of wild timber species, particularly olive (*Olea* sp.), during the Iron Age, suggesting a shift in landscape ecology driven by horticulture (Benzaquen et al., 2019).

3 Methods

In 2014, ELRAP collected a total of 57 sediment samples (1023.5 liters) from all KAJ loci, except from loci within structural features (i.e., architectural fill) (Hoshino, 2014). This systematic sampling avoids issues associated with opportunistic sampling (Lennstrom & Hastorf, 1995), which we note has been cited as a concern with legacy datasets in the region (Farahani et al., 2016:28). The samples were floated in a froth flotation machine that recirculated water using a gas pump. The light fraction, consisting of 54 samples, was recovered with a 0.25 mm mesh and dried indoors, out of direct sunlight. These samples were exported to the United States and analyzed at the University of California, San Diego, under the supervision of Dr. Jade d'Alpoim Guedes. The samples were filtered through geological sieves (4 mm, 2 mm, 1 mm, 0.5 mm, and 0.25 mm fraction). Macrobotanical material was extracted from all sample fractions, although wood charcoal fragments were only extracted from the 1 mm fraction and above. All archaeobotanical material was counted and weighed, a total of 4793 whole and fragmentary carbonized specimens. In 2014, Dr. Brita Lorentzen analyzed the wood charcoal from the site (Lorentzon 2017; Liss et al., 2020: Table 3).

Identifications were based on comparative collections from the d'Alpoim Guedes lab and reference books, including *Digital Atlas of Economic Plants in Archaeology (*Neef et al., 2012*)* and *Identification of Cereal Remains from Archaeological Sites (*Jacomet*,* 2006*)*. In addition to wood charcoal (n = 30,579), the remains were sorted into 31 taxa, 21 at the genus/species level (n = 1924) and 10 at the family level (n = 87). There were also 31 unidentified categories (n = 113), fruit and nut epicarps (n = 7), and an unidentified fruit (n = 1). Some (n = 2545) specimens were not identifiable due to small size or poor preservation. Table 1 presents the full weight and count data for identifiable taxa, aggregated from the entire site. Counts and weights by context are presented in Supplemental Table 1.

4 Results

Fruits, particularly the date palm (*Phoenix dactylifera*), consistently dominate the samples through all time periods (Fig. 3). Other fruit and nut taxa included figs (*Ficus* sp.), pistachio (*Pistacia* sp.), grapes (*Vitis* sp.), and pomegranates (*Punica* sp.) (Table 1). The samples mostly consist of easily obtainable, local fruit taxa that require little preparation and could be preserved through drying or pickling. These high-calorie snacks would have been a nutritious treat for a working population, similar to those enjoyed at the ore-processing sites within the Timna Valley (David et al., 2022:244). At Khirbat al-Jariya, these fruit taxa are particularly abundant in the Area B building. Although figs (*Ficus* sp.) dominate the standardized count by density, dates become the most abundant fruit when the counts are standardized by the average number of seeds per fruit (Table 2). There is no meaningful pattern of fruit distribution as aggregate, but Rooms 4 and 6 exhibited the largest concentration of date palm pits (Fig. 4).

Figure 5 shows the proportion of foods requiring preparation (all pulses, all grains, *Vicia* sp.; “prep”) to those which do not (all fruits, all nuts; “snacks”) in different combinations. The first two bars show Prep vs Grapes, Figs, Dates, Nuts (*Pistacia* sp., cf. *Pistacia* sp., Nutshell/Endocarp) and Other Fruits (*Punica* A, *Punica* B, *Rubus* sp., Undet Fruit 1) with density calculated two ways, using both counts and weights divided by the sum of the volume of all soil samples collected from a particular context. Importantly, none of the following figures include Basket 10,684 EDM 561, for which the sample number and soil volume were not recorded on the original package and density could not be calculated**.** The second two bars show the same density by count and mass, but all “snack” foods are amalgamated in a single category.

The next most abundant taxa in terms of counts are pulses, including lentil (*Lens* sp.), pea (*Pisum* sp.) and chickpea (*Cicer* sp.) (Table 1 **and** Fig. 3). The lentil proportions were far greater than the pea and chickpea proportions. A few of these lentil specimens appear to have been cooked. Following pulses, wheat and barley represent the next most abundant category by count. It is possible that these pulses were transported uncooked to the site to be prepared into soups or dips.

Several different types of wheat and barley were recovered (Table 1**)**. A total of 9 grains of poorly preserved wheat (*Triticum* sp.) and one bread wheat (*Triticum aestivum*) rachis was found in our samples. Several well-preserved grains and fragments of barley (*Hordeum vulgare*) were also found in our samples. Three rachises of two-row barley were found, which might suggest that barley was present

Fig. 3 Ratio of grains to pulses to weeds to particular fruits, by stratum and area, standardized by counts per volume and weights per volume, including both whole and fragmented specimens

primarily in two-row form. In addition, several fragments of hulled barley and 3 grains of poorly preserved specimens of either oat or rye were also recovered. A number of very poorly preserved grains that were only identified to the Cerealia level, but were likely wheat or barley, were retrieved. Only a small number of rachis bases and spikelet forks, which are common indicators of crop processing, were present. These were concentrated primarily in Area C, a likely midden. Other economic taxa unearthed at the site include flax seeds (*Linum usitatissimum*).

Table 2 Estimated number of fruits corresponding to low and high estimates based on the total number of recovered seeds

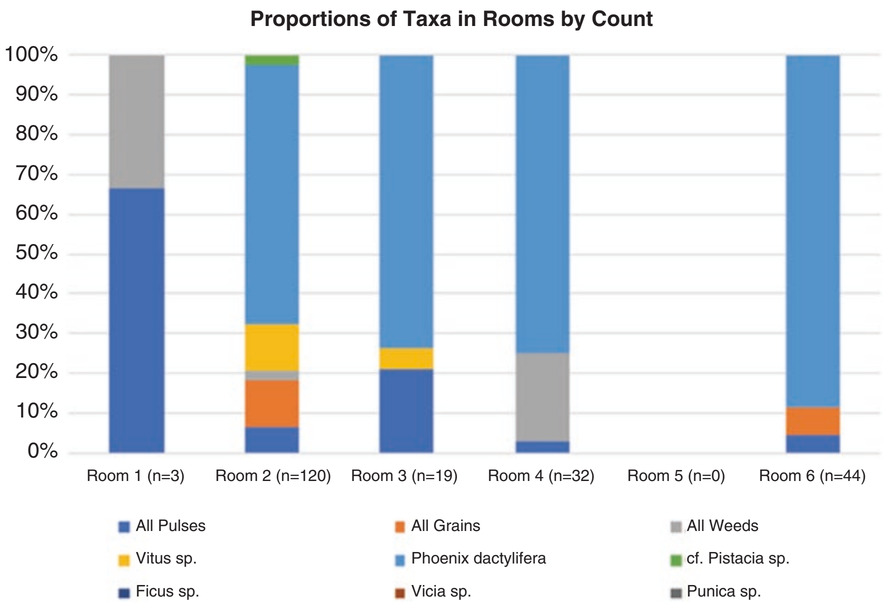
Taxa	Count (seeds)	No. fruits, low estimate	No. fruits, high estimate
Ficus sp.	1082	0.67625	36.06667
Phoenix dactylifera	518	518	518
Vitis sp.	208	52	104

High estimates per fruit are 2 seeds per Vitis sp., 30 seeds per Ficus sp., and 1 seed per Phoenix dactylifera. Low estimates per fruit are 4 seeds per Vitis sp., 1600 seeds per Ficus sp., and 1 seed per Phoenix dactylifera

Wild taxa were dominated by various wild grasses (Poaceae). Other taxa included bedstraw (*Galium* sp.), *Coix* sp., and members of the sedge (Cyperaceae) family, *Chenopodium* sp., Malvaceae family, and Boraginaceae family, as well as a single fruit of the nightshade family (Solanaceae) and several juniper fruits.

The comparisons of taxa by room (Fig. 4) show that rooms 2, 3, 4 and 6 are dominated by date palms (*Phoenix dactylifera*). Room 2 has the largest specimen count (n = 120), and although dominated by date palms, it also includes pulses, grains, weeds, grapes (*Vitus* sp.) and pistachios (cf. *Pistacia* sp.). The samples from Rooms 2 and 6 do contain grains, including the only evidence of chaff that could have been removed during food preparation. Room 1 (n = 3) and room 5 (n = 0) contain too little material to make meaningful conclusions.

It is clear that foodstuffs coded as "snack" foods dominate the collection, particularly when considering the site in aggregate (Fig. 5). To assess how the distribution of food remains was concentrated, a discriminant analysis was performed in which the density of Prep, *Phoenix* sp., *Vitis* sp., *Ficus* sp., Other Fruit and Nut from each sample were coded by context (Room 1, 2, 3, 4, 5, 6, Area C, in a second analysis by Strata, and in the third by exterior/interior). If there was a meaningful pattern of a particular taxa being deposited in specific locations, we would expect clustering by context. The discriminant analysis was run twice using density by count and mass, each time yielding a misclassification rate of 44/53, just over 75%. In other words, the relative proportion of snack to prep food showed no meaningful patterning throughout the excavated contexts. It is unlikely that activity areas were demarcated in a way that produced patterned deposition of the macrobotanical remains, either between Areas B and C, or within the different rooms of Area B. There was likewise no statistically significant pattern to the distribution of plant remains by strata or by room (d'Alpoim Guedes et al., 2019a, b). It is unlikely that food-processing and consuming and discarding activities occurred within specific areas of the site because the discard of plant remains was not structured in a way that suggests particular rooms had particular culinary functions. This makes intuitive sense for a practice of convenient snacking that took place throughout all the spaces of the site.



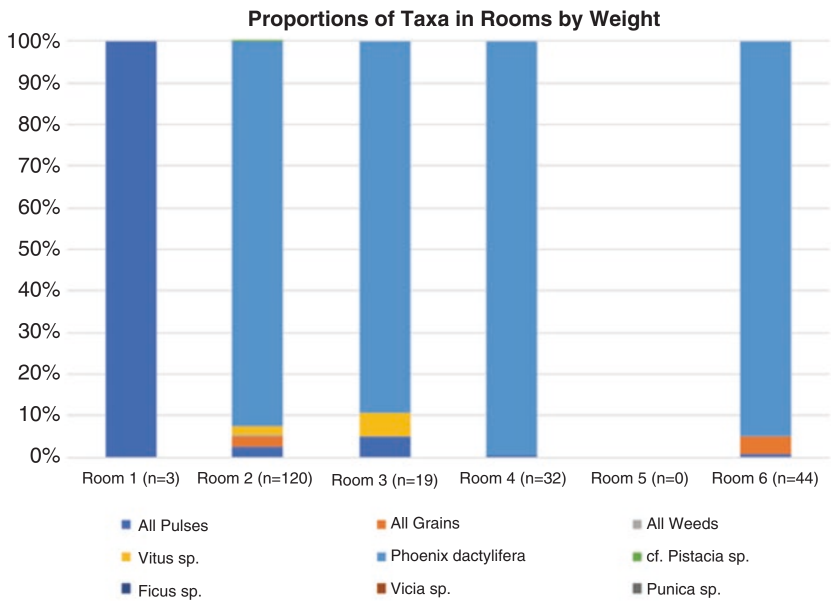


Fig. 4 Ratio of grains to pulses to weeds to particular fruits, by room, standardized by counts per volume and weights per volume, including both whole and fragmented specimens. "N" represents the total number of specimens per room

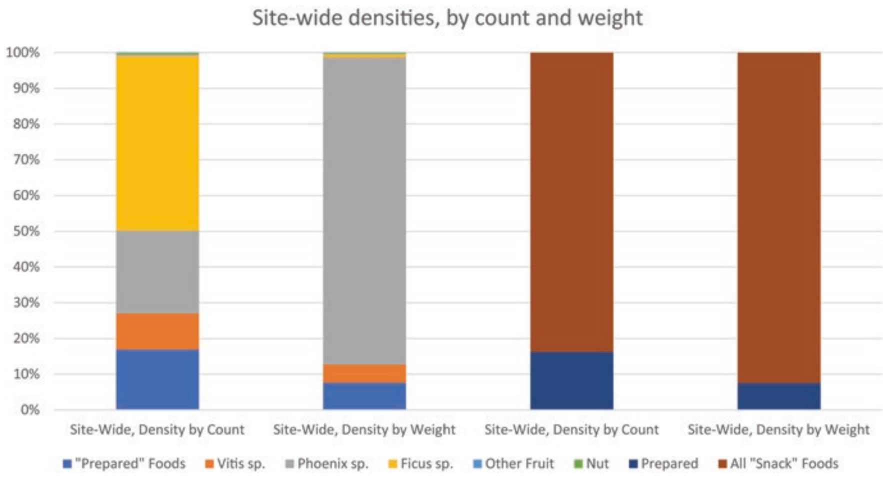


Fig. 5 Site-wide densities of prepared foods to snack foods by count and weight. The category "Prep" refers to those foods that requiring processing (all pulses, all grains, *Vicia* sp.) whereas those foods that do not (Grapes, Figs, Dates, *Pistacia* sp., cf. *Pistacia* sp., Nutshell/Endocarp, *Punica* A, *Punica* B, *Rubus* sp., and Undet Fruit 1) are included in the category "Snack"

5 Discussion

We compared our results to data from other nearby or contemporary sites for which comparative data are available: the Wadi Faynan survey (Austin, 2007; Kennedy, 2007), Wadi Arabah (David et al., 2022; Engel, 1993), Tel Meggido (Benzaquen et al., 2019), Khirbat al-Mudayna al-'Aliya (Farahani et al., 2016), Tall Dhirbat (Fatkin et al., 2011), Tel Batash (Kislev et al., 2006), and Tall al-'Umayri (Ramsay & Mueller, 2016). Raw counts were only available for Tall al-'Umayri, Mudayna al-'Aliya, Meggido, and the Wadi Faynan survey, although only nine contexts that exhibited the most specimens were reported for Tall al-'Umayri. We compared counts - which were more commonly reported than weights - of taxa associated with prepared foods and those labeled as "snack" foods, to that of Khirbat al-Jariya (Fig. 6).

The sites outside of the Wadi Faynan region show a greater reliance on cultivated cereals, whereas samples taken from the trenches of the Wadi Faynan survey show a degree of exploitation of convenient plant foods similar to that present at Khirbat al-Jariya. These samples were recovered from the 1998 survey of WF16, a Pre-Pottery Neolithic A site, the majority from midden contexts (Kennedy, 2007:425). Although considerably predating the later Iron-Age settlements, it indicates a long history of exploiting local plant foods within the Wadi Faynan. More contemporary paleobotanical studies show that local resources tend to dominate the subsistence base of various Bronze- and Iron-Age settlements (Benzaquen et al. 2019; Engel, 1993; Farahani et al., 2016; Fatkin et al., 2011; Ramsay & Mueller, 2016). Cereal agriculture was complemented by arboriculture and orchard vine crops (Benzaquen

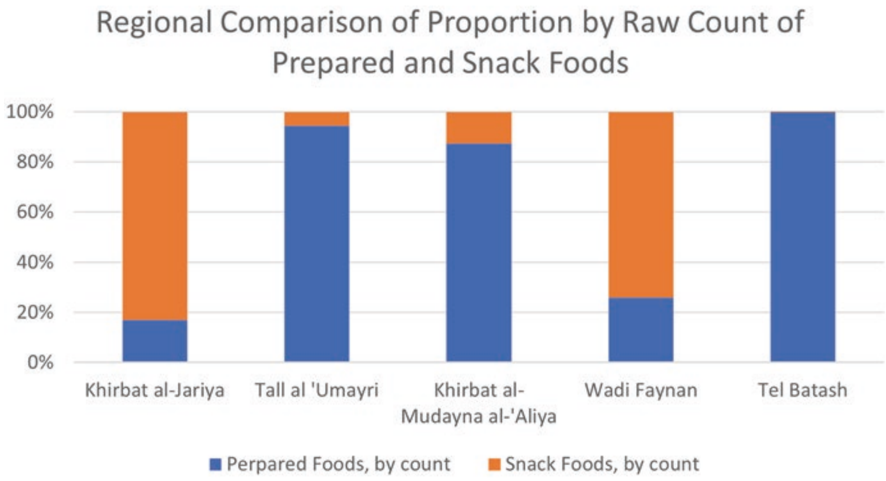


Fig. 6 Regional comparison of proportion (by raw count) of prepared and snack foods. Volumes of samples were only reported for Khirbat al-Mudayna al-'Aliya and Wadi Faynan, so comparison by count density was not possible for all sites but produced an overall similar pattern. It is not clear how the macrobotanical remains were collected from Tel Batash (Kislev et al., 2006), by hand or by flotation, so some sample bias may be present towards larger, more easily recognizable specimens

et al., 2019; Knabb et al., 2016; Ramsay & Mueller, 2016). Samples documenting the transition from the Late Bronze Age to Iron Age I from Tall al-'Umayri exhibited "no evidence of long-distance exchange or redistribution of surplus by elites[,]" with local plant husbandry "dominated by domesticated subsistence crops such as wheat, barley, legumes, grapes, figs, and nuts." (Ramsay & Mueller, 2016:16) During this time, based on "the material culture recovered[,]" the authors indicate that long-distance trade declines (Ramsay & Mueller, 2016:16).

That is not to say that nonlocal resources were absent from Iron-Age subsistence. It is worth noting that during the Iron Age, Tel Meggido began making greater use of nonlocal fuelwoods and the wood of imported arboriculture species, such as almond (*Amygdalus communis*) and Persian walnut (*Juglans regia*; Benzaquen et al., 2019:52). The exploitation of local resources is coupled with local processing, which took place in dedicated areas often separate from storage of grain ready for human consumption and/or animal fodder. This is typically characterized in the archaeological record by high frequencies but low ubiquities of glumes and rachises of cereals (Farahani et al., 2016; Kennedy, 2007; Ramsay & Mueller, 2016). This stands in contrast to the high frequency and high ubiquity of fruit taxa exhibited at Khirbat al-Jariya.

Another metal-working context, Site 30 in the Timna Valley, Israel, demonstrates a similar dominance of fruit and nut taxa, particularly dates, grapes, and the Atlantic pistachio (David et al., 2022: Supplemental Table 1). Despite differences in recovery techniques and predating Khirbat al-Jariya by a few centuries, the data is similar enough to support the general assertion that these likely nomadic-working camps, likely embedded within larger political and economic entities (Ben-Yosef, 2019; Ben-Yosef, 2021; David et al., 2022:235), were fed through locally acquired (and easily preserved) snack foods, with processed foods prepared elsewhere.

The results reported here appear to indicate that–at least at Khirbat al-Jariya–the inhabitants of the Wadi Faynan relied more heavily on readily available foodstuffs, likely employing arboriculture. At Khirbat al-Jariya and the Wadi Faynan survey, the ratios of chaff to grain, chaff including rachises, glumes, and non-useful plant products removed during processing, are much lower than that of Tall al-'Umayri, although only moderately lower than that of Khirbat al-Mudayna al-'Aliya (Fig. 7). The lower the ratio, the greater the proportion of end-stage food materials ready for consumption, whereas a higher proportion of chaff may indicate on-site production. Consumption and production represent a spectrum of behavior, rather than a binary (Stevens, 2003), and so it could be argued that Khirbat al-Jariya and Tel Batash are closer to the consumer side of the spectrum, relying on trade with or direct support from other polities – in the case of Khirbat al-Jariya, potentially support from Khirbat en-Nahas, which may have controlled the exchange of copper, supplemented further by locally available convenient snack foods.

It is important to consider how sample bias may influence the chaff:grain ratio, and accordingly how we interpret the consumption-production spectrum. Tel Batash offers an example of how the spatial patterning of paleobotanical material, and sampling methodology, may influence the interpretation of data. The paleobotanical material from Tel Batash was dominated by a single storage jar full of wheat grains (Locus 437, n > 147,000). That, combined with the apparent lack of flotation (no

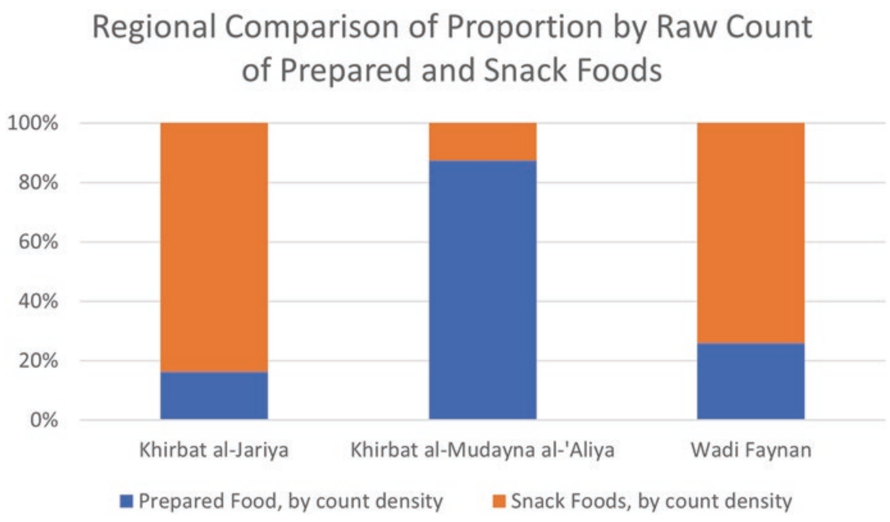


Fig. 7 Site-wide proportions by raw count of grain to chaff. The Wadi Faynan survey reported chaff present only in a fragment of mudbrick that contained impressions of chaff fragments in four samples, but these were not identified (Kennedy, 2007:424). The macrobotanical remains from Tel Batash were dominated by a single storage jar full of wheat grains (Locus 437, n = 147,000), but the ratio is not remarkably changed when this context is removed

such recovery technique was described by the authors), could lead to underrepresentation of chaff and grain from other excavated contexts, and potentially misrepresent a site as a "consumer" site. Similarly when discussing the Timna Valley material, whereas we emphasize the strong positive signal of snack food recovered from Site 30, due to the lack of systematic flotation (David et al., 2022:231) we cannot be as confident in the lack of evidence for processing.

Processing, discard of chaff, and storage are also often spatially organized behaviors. The case study from Khirbat al-Mudayna al-'Aliya (Farahani et al., 2016:55) shows how room function can be inferred from the paleobotanical record, identifying different stages of processing within a single site. It is likely all sites employed some combination of processing and storage. In the case of Khirbat al-Jariya, the systematic sampling and flotation recovery allows us to say that there is less evidence for on-site processing and further evidence for the reliance on convenient, locally available foodstuffs. In other words, there is both positive evidence for this snacking behavior and negative evidence for food preparation, despite the systematic flotation used during the 2014 ELRAP field season. The population of Khirbat al-Jariya likely worked within the site and lived, perhaps cooked, outside of the excavated portion of the site. We emphasize the positive evidence (high frequency and ubiquity) of casual snacking behavior and comparison to the archaeological signal of these same snack/prep taxa at other sites, particularly the results of the Wadi Faynan survey. Future excavations may reveal evidence of crop processing at a different location within Khirbat-al-Jariya for it is unlikely that smelting and dwelling areas directly overlapped (Ben-Yosef, 2019:366; Ben-Yosef, 2023:238). Focus on stone architecture and other highly visible features may prevent us from fully describing food preparation practices of seasonal nomads (Ben-Yosef, 2021:162–163). Therefore we emphasize the positive archaeological evidence for the casual snacking behavior practiced within the working environment of Khirbat al-Jariya and specific correlates of that behavior, including the lack of spatial organization of discarded foodstuffs and higher signal of snack foods compared to prepared foods as compared to other contemporary, permanent settlements.

6 Conclusion

The presence of glume bases, rachises, and culms, which are removed in the early stages of cereal processing, has been attributed to "producer" sites that process the grain, whereas higher ratios of seeds to chaff may represent "consumer" sites (Jones, 1985; Stevens, 2003). This model has been criticized as oversimplifying the complex dynamics of supplying sites across a landscape but provides a useful starting point for interpreting archaeobotanical assemblages. Although producer/consumer is a spectrum, not a binary, in this case, we have neither an abundance of chaff nor seeds. There is no evidence of the full spectrum of food harvesting and preparation, from cutting to threshing, sieving, and grinding, nor of storage of large quantities of grains onsite. If food made from cereal was present, it was introduced to the site in

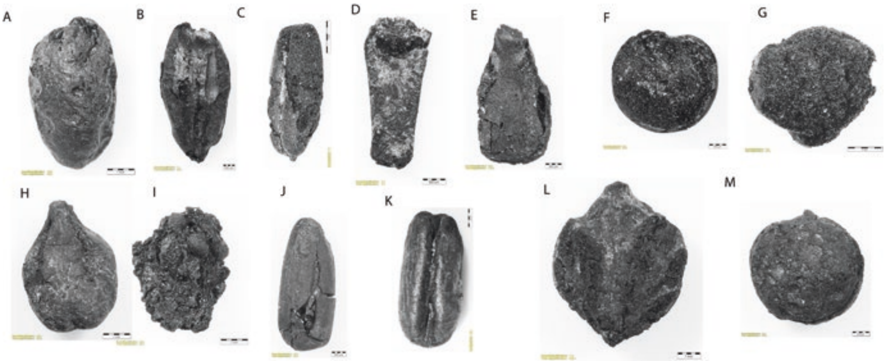


Fig. 8 Domestic taxa recovered from Khirbat al-Jariya. (**a**) *Triticum* sp.; (**b**) *Hordeum vulgare* (hulled); (**c**) cf. *Avena/ Secale* sp.; (**d**) *Hordeum vulgare* rachis (two row); (**e**) *Linum* sp.; (**f**) *Lens culinaris* (cooked); (**g**) cf. *Vicia faba*; (**h**) *Vitis* sp. (**i**) *Ficus* sp. (fruit and seeds); (**j**) *Punica* sp.; (**k**) *Phoenix dactylifera*; (**l**) *Cicer* sp.; (**m**) *Pisum sativum*

a form that is not represented by the paleobotanical assemblage, such as pre-processed flour or breads. Instead, our macrobotanical analysis suggests that the inhabitants of Khirbat al-Jariya were favoring locally available, easily preparable foods (Figs. 8 and 9), although these were likely only seasonally available (Levy et al., 2018). If these were the primary food resources on which the inhabitants of Khirbat al-Jariya relied, then the site may have only been seasonally occupied.

The inhabitants of Khirbat al-Jariya did have access to non-local, pre-processed foodstuffs - a cup-spouted jar likely used for olive oil was recovered from Area B. Nevertheless, the primary source of food appears to have been convenient "snack foods" focused on dried, pickled, or raw fruits and nuts, and potentially the transport of processed foods like bread or flour. It is likely that Khirbat en-Nahas, the center of the copper industry in Faynan, mediated access to additional foodstuffs, and horticultural products may have been supplied by the perennial springs near Khirbat al-Ghuwayba. The population of Khirbat al-Jariya was an itinerant one, taking advantage of local resources but not establishing a permanent living space.

Acknowledgments The authors would like to thank Drs. Thomas E. Levy and Mohammad Najjar and the UCSD Levantine and Cyber-Archaeology Laboratory for providing access to the collection. Special thanks to Dr. Neil G. Smith, Craig Smitheram, Rosemary Y. Hoshino, Marc Wallace, and the local Bedouin of Qirayqira and Faynan for their assistance in the field and the lab. Also, thanks to Dr. Barbara Porter of the American Center of Oriental Research (ACOR) in Amman and Dr. M. Jamhawi, former Director General of the Department of Antiquities of Jordan. Thank you to the students in Dr. d'Alpoim Guedes's 2018 Introduction to Paleoethnobotany course for assisting in the analysis: Katrina Cantu, Clara Dawson, Shelby Jones-Cervantes, Brandon Gay, Isabel Hermsmeyer, Xiyuan Huang, Bridget C. Lawrence, Sunyoung Park, Eric Rodriguez, Julianna Santillan-Goode, Sarah Sheridan, Fabian Humberto Toro, Isabel Villasana, Emma Villegas, and Zhen Yu.

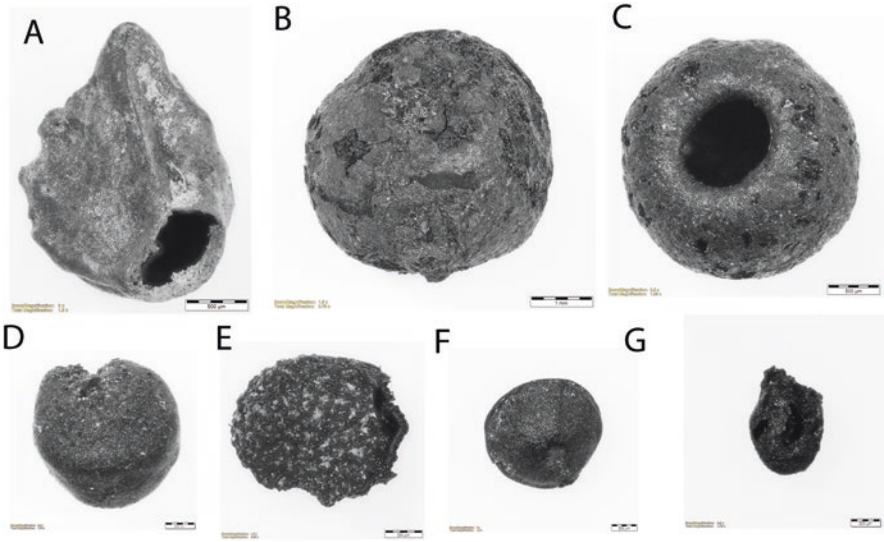


Fig. 9 Wild taxa recovered from Khirbat al-Jariya. (**a**) Boraginceae; (**b**) *Juniperus* sp.; (**c**) *Galium* sp.; (**d**) Malvaceae; (**e**) Solanaceae; (**f**) *Chenopodium* sp.; (**g**) Cyperaceae

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